A new genus of Lichomolgidae (Copepoda: Poecilostomatoida) associated with a phoronid in Hong Kong

Geoffrey A. Boxshall
Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD

Arthur G. Humes
Boston University Marine Program, c/o Marine Biological Laboratory, Woods Hole, Massachusetts 02543, U.S.A.

Introduction

Copepods are rarely reported as parasites or associates of the lophophorate phyla Bryozoa, Brachiopoda and Phoronida. Two new harpacticoids, *Tegastes knoepffleri* and *Peltobradya bryozoophila*, were described by Medioni & Soyer (1967) as associates of the bryozoans *Schizobrachiella sanguinea* (Norman) and *Schizomavella linearis* (Hassall) respectively, at Banyuls-sur-Mer in southern France. Recently Humes & Boxshall (1988) described a new genus of the family Myicolidae which occurs on the intertidal brachiopod *Lingula anatina* Lamarck collected at Starfish Bay, New Territories, Hong Kong. This is the first known copepod associate of a brachiopod. Examination of other invertebrates collected at the same time in Starfish Bay has revealed a copepod associated with a phoronid, *Phoronis australis* Haswell, which is itself an associate of the burrowing anemone *Cerianthus filiformis* Carlgren. The phoronid lives embedded in the mucilaginous tube of the *Cerianthus* (Morton & Morton, 1983). Three copepods were found in the lophophore of the phoronid and are described below as a new genus of the family Lichomolgidae.

Material and Methods

The phoronid was collected by a diver at a depth of 3 to 5 m in Hoi Sing Wan (Starfish Bay). The phoronid was placed in a plastic bag, transported to the laboratory and examined live. The copepods were picked off and fixed in 70% ethanol. All figures were drawn with the aid of a camera lucida.

Descriptions

Genus *PHORONICOLA* gen. nov.

DIAGNOSIS. Body cyclopiform. Urosome in ♀ 4-segmented, in ♂ 5-segmented. Caudal ramus with 6 setae. Rostrum broad. First antenna 7-segmented. Second antenna 4-segmented, with the formula 1, 1, 4 + 1 articulated claw, and 4 + 3 articulated claws.

Labrum incised medially. Mandible tapering smoothly into lash. Paragnath a small hairy lobe. First maxilla with 3 setae. Second maxilla with long slender lash, 2 setae near base of lash, and a short proximally directed seta. Maxilliped in ♀ 3-segmented with pointed tip, in ♂ 4-segmented.

Legs 1–4 with 3-segmented rami, except for leg 4 endopod which is 1-segmented. Leg 4 exopod armed I–0; I-1; I, I, 5: endopod armed with an apical serrate spine. Leg 5 with a free segment bearing 1 apical spine and 1 subapical seta. Leg 6 in ♀ represented by 2 setae situated on a small lobe at each genital aperture, in ♂ represented by single seta on genital flap.

Associated with Phoronids.

TYPE SPECIES. *Phoronicola spinulatus* gen. et sp. n.

ETYMOLOGY. The generic name is derived from *Phoronis*, the host genus, and the Latin *-cola*, meaning inhabiting.

Phoronicola spinulatus gen. et sp. n.

TYPE MATERIAL. 1♀ and 2♂♂ from 1 *Phoronis australis* collected in 3–5 m in Hoi Sing Wan (Starfish Bay), on the southern shore of Tolo Harbour, New Territories, Hong Kong by Dr P. G. Oliver on 3 April 1986. Holotype ♀ (BM(NH) Reg. No. 1987.415), and 2♂♂ paratypes (BM(NH) Reg. Nos 1987.416–417) deposited in the British Museum (Natural History), London.

FEMALE. Body (Fig. 1A) with stout prosome and slender urosome. Length (excluding caudal setae) 1·17 mm and greatest width 0·49 mm. Length to width ratio of prosome 1·41:1. First pedigerous segment fused with cephalosome. Ratio of length of prosome to that of urosome 1·47:1.

Segment bearing leg 5 (Fig. 1B) 62 × 139 μm. Genital segment elongate, 189 μm long, anterior half with convex lateral margins and broader (133 μm) than posterior half (straight sides and width of 80 μm). Genital areas located dorsolaterally about in middle of segment. Each area bearing a small process armed with 2 smooth setae (Fig. 1B), an apical seta 23 μm long and a subapical seta 29 μm long. Postgenital segment 52 × 72 μm, anal segment 82 × 65 μm.

Caudal ramus (Fig. 1A) 3·0 times longer than wide (84 × 28 μm), bearing 6 setae. Outer lateral seta 63 μm long, naked and positioned on mid-dorsal surface. Dorsal seta naked, 55 μm long. Outermost terminal seta 84 μm long, innermost terminal seta 106 μm and 2 median terminal seta 377 μm (outer) and 501 μm (inner); all 4 of these setae plumose.

Rostrum (Fig. 1C) broad based, moderately well defined. First antenna 7-segmented as in male (Fig. 1D); formula for armature: 4, 12, 6, 3, 4+1 aesthete, 2+1 aesthete and 7+1 aesthete. Two setae on first segment, 3 on fourth segment, 1 on sixth segment and 5 on seventh segment plumose. Second antenna (Fig. 1E) 4-segmented; armature 1, 1, 4+1 articulated claw, and 4+3 articulated claws.

Labrum (Fig. 1C) with 2 broad, tapering lobes. Mandible (Fig. 1F) with a slender base carrying distally a bipectinate blade. Paragnath a small hairy lobe. First maxilla (Fig. 1G) conical, with 3 elements. Second maxilla (Fig. 2A) 2-segmented. First segment unarmed. Second segment drawn out into a slender apical lash with a comb of strong spinules along outer margin, and fine spinules along inner margin. Second segment armed with a stout barbed spine on medial margin, a naked spine near its base and a fine, proximally directed setule near the base of the outer margin. Maxilliped (Fig. 2B) 3-segmented. First segment unarmed; second segment bearing a naked seta and a stout spinose seta. Third segment armed with a naked spine, terminating in slightly curved spiniform process bearing 3 spinules. Ventral area between bases of maxillipeds (Fig. 2C) and first legs only slightly protuberant.

Legs 1–4 (Figs 2D–F, 3A) biramous with 3-segmented rami except for endopod of leg 4 being 1-segmented. Spine and seta formula of legs as follows:

P1	coxa 0–1	basis 1–0	exp I–0; I–1; III , I, 4 enp 0–1; 0–1; I, 5
P2	coxa 0–1	basis 1–0	exp I–0; I–1; III, I, 5 enp 0–1; 0–2; I, II, 3
P3	coxa 0–1	basis 1–0	exp I–0; I–1; II, I, 5 enp 0–1; 0–2; I, II, 2
P4	coxa 0–0	basis 1–0	exp I–0; I–0; I, I, 5 enp I

Outer distal angle of legs 1–2 coxae with patch of fine spinules. Inner margin of basis of legs 3–4 with rows of long hairs. Rows of hairs present on inner margins of all exopod segments and outer margins of all endopod segments. Leg 4 (Fig. 3A) with 1-segmented endopod 42 μm in length, bearing a few spinules proximally on inner margin and a longer row of spinules on outer margin. Apical element spiniform, 62 μm long, armed with serrate membrane on both sides.

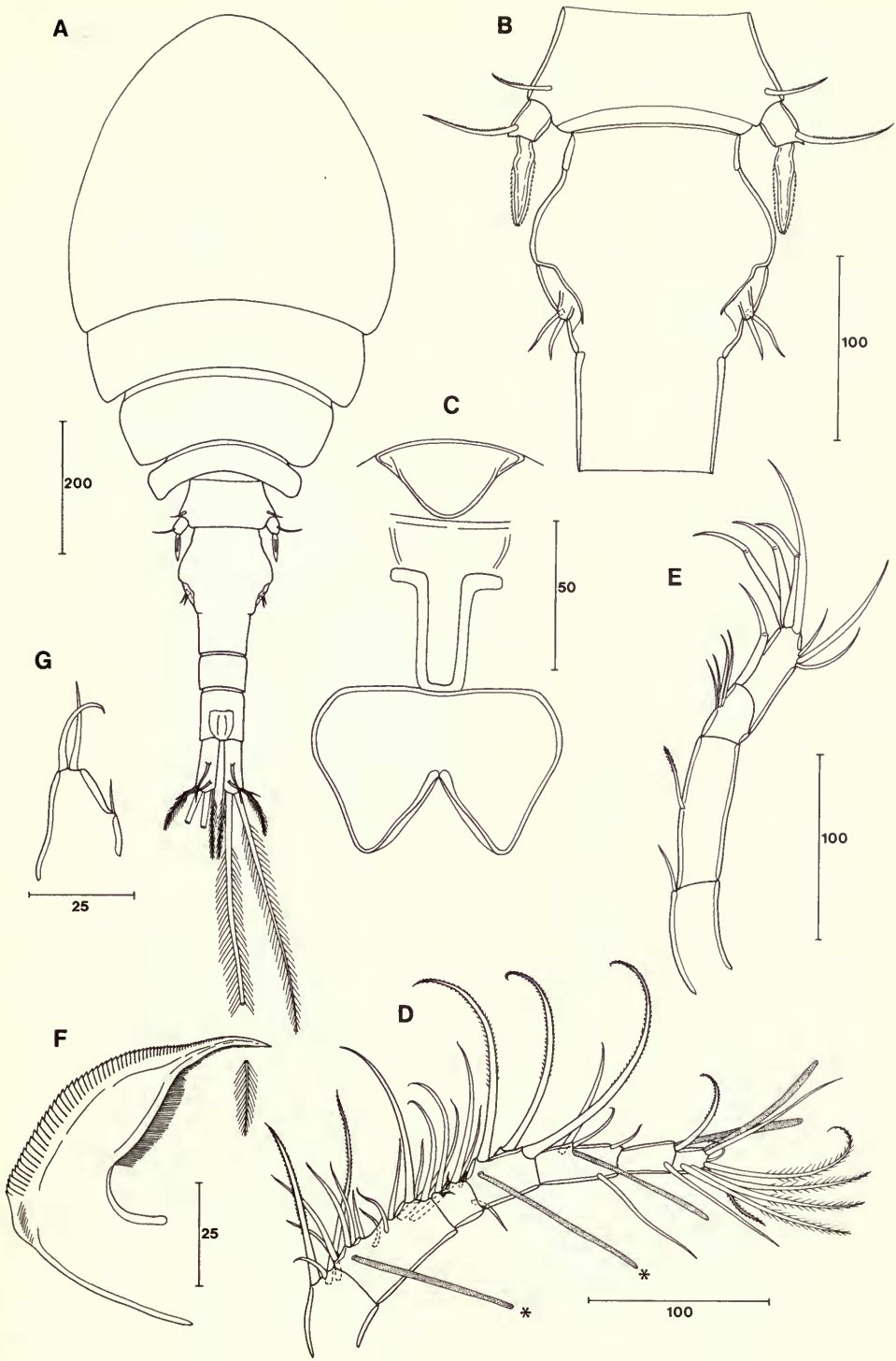

Fig. 1 *Phoronicola spinulatus* gen. et sp. nov. A, Holotype female, dorsal; B, Fifth pedigerous and genital segments, dorsal; C, Rostrum and labrum, ventral; D, Male first antenna, anteroventral (with aesthetes absent in female marked with asterisks); E, Female second antenna, posterior; F, Mandible, posterior; G, First maxilla, anterior. All scales in μm.

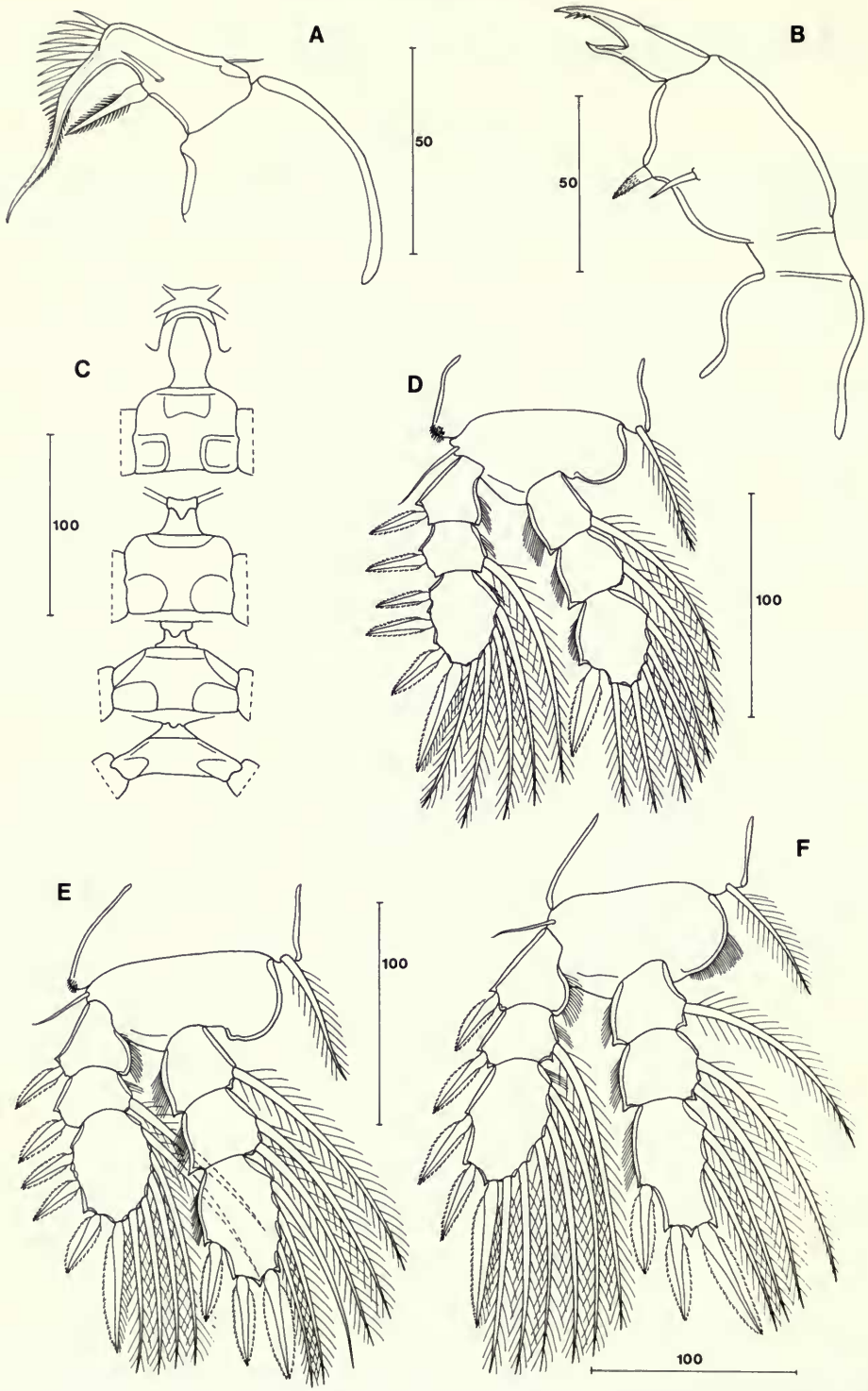

Fig. 2 *Phoronicola spinulatus* gen. et sp. nov. Female, A, Second maxilla, posterior; B, Maxilliped, posteromedial; C, Ventral body wall between maxillipeds and swimming legs; D, Leg 1, posterior; E, Leg 2, posterior; F, Leg 3, posterior. All scales in μm.

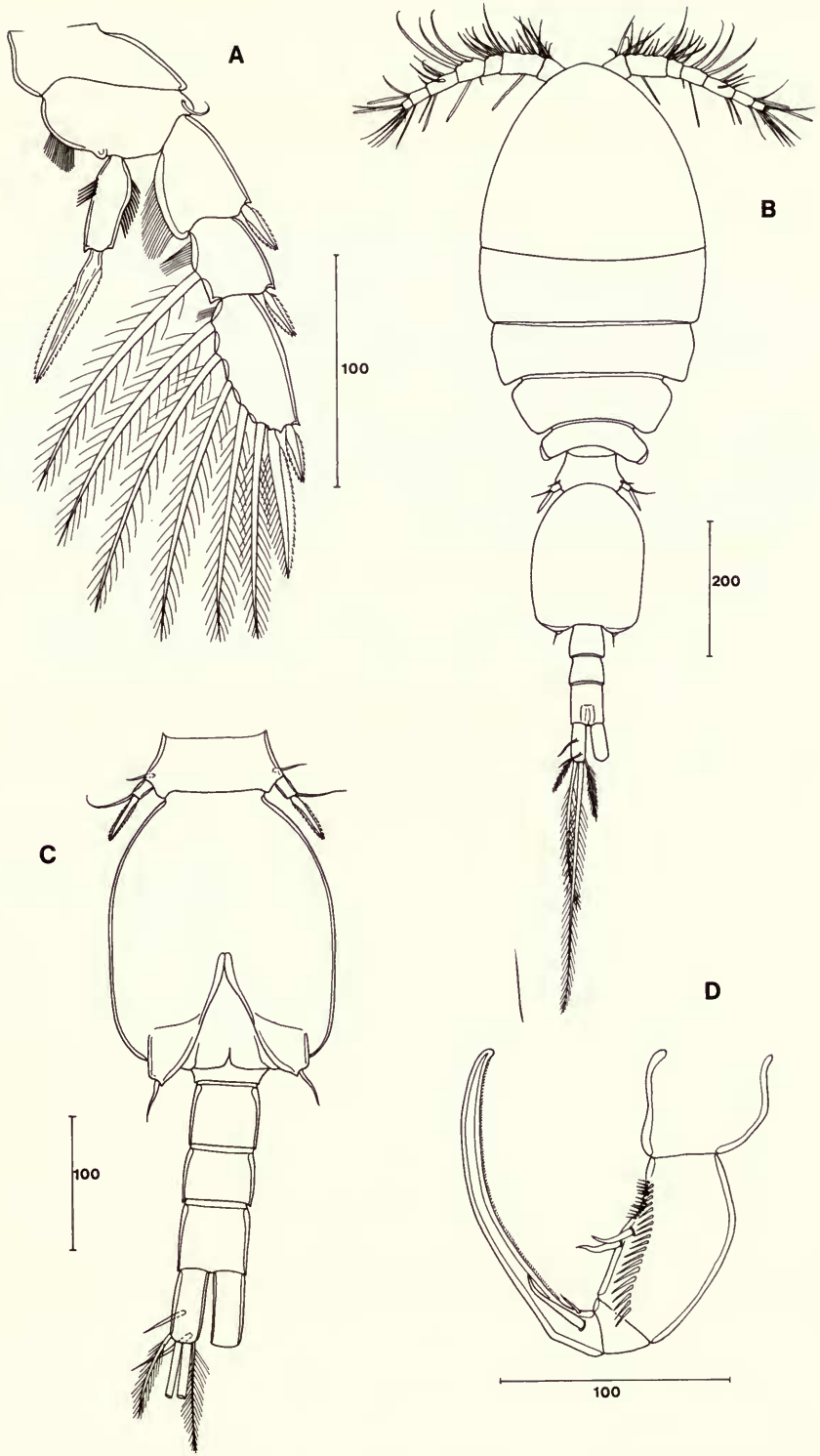

Fig. 3 *Phoronicola spinulatus* gen. et sp. nov. A, Female leg 4, posterior; B, Paratype male, dorsal; C, Urosome, ventral; D, Maxilliped, posteromedial. All scales in μm.

Leg 5 (Fig. 1B) free segment about 1·2 times longer than wide (21 × 18 μm), with a small spiniform projection at outer distal angle. Strong spiniform apical element 49 μm long, armed with serrate membrane both sides; subapical seta 56 μm long, with tiny spinules along anterior margin. Dorsal seta 35 μm. Leg 6 represented by process bearing 2 setae located in genital area (Fig. 1B).

Egg sacs not seen.

Colour of live specimen white.

MALE. Body (Fig. 3B) similar to that of female in general form. Length 1·04 mm excluding caudal setae, greatest width 0·33 mm; length to width ratio of prosome 1·73:1. Ratio of length of prosome to length of urosome 1·25:1.

Segment of leg 5 (Fig. 3C) 43 × 101 μm. Genital segment 214 × 166 μm. Three postgenital segments from anterior to posterior 49 × 51, 41 × 52 and 54 × 51 μm.

Caudal ramus similar to that of female but shorter, 56 × 20 μm, ratio 2·8:1.

First antenna (Fig. 1D) 7-segmented; lengths of segments measured along posterior border 26, 61, 19, 34, 44, 29 and 18 μm respectively. Armature formula as for female except for additional aesthetes on segments 2 and 4 (marked with asterisks on Figure 1D).

Rostrum, second antenna, labrum, mandible, paragnath, first and second maxilla like those of female. Maxilliped (Fig. 3D) slender, 4-segmented. First segment stout, unarmed. Second segment with 2 naked inner setae, a row of spinules along inner surface and a shorter row of fine spinules proximally. Third segment unarmed. Claw comprising short basal section representing the fourth segment, armed with 2 unequal setae. Claw curved, 146 μm in length, bearing a row of fine spinules along concave margin.

Legs 1–4 similar to those of female. Leg 5 (Fig. 3C) free segment more elongate than in female, 1·7 times longer than wide (17 × 10 μm). Apical serrate element 38 μm long, subapical seta 40 μm.

Leg 6 (Fig. 3C) forming the posteroventral genital flap closing the genital aperture, armed with a single apical seta 34 μm long.

Spermatophores not seen.

Colour of live specimens white.

ETYMOLOGY. The specific name *spinulatus* refers to the spiniform nature of the single serrate element on the endopod of leg 4.

REMARKS. The new genus belongs to the family Lichomolgidae. The lichomolgid genera *Aspidomolgus* Humes, *Haplomolgus* Humes & Ho, *Kelleria* Gurney, *Lichomolgella* Sars, *Octopicola* Humes, *Paramacrochiron* Sewell, *Pseudomacrochiron* Reddiah, *Sewellochiron* Humes and *Telestacicola* Humes & Stock share with the new genus the 1-segmented endopod of leg 4 (Humes & Stock, 1973). Most species of *Macrochiron* Brady also exhibit this 1-segmented condition. However, none of these genera has only a single apical element on the leg 4 endopod. *Aspidomolgus* (II, I), *Kelleria* (II, 1), *Octopicola* (2, 1) and *Telestacicola* (II, 1) all have 3 elements, *Lichomolgella* (II), *Macrochiron* (II), *Paramacrochiron, Pseudomacrochiron* (II) and *Sewellochiron* (II) have 2 apical elements and *Haplomolgus* has none.

The presence of one articulated claw on segment 3 and 3 claws on segment 4 of the second antenna is recorded in only a single species of *Acaenomolgus* Humes & Stock, within the Lichomolgidae. Members of this genus, however, have a 2-segmented leg 4 endopod. *Kelleria* has 1 and 2 articulated claws on the third and fourth segments of the second antenna respectively and has a 1-segmented endopod on leg 4 but differs from *Phoronicola* in possessing an additional urosome segment in both sexes and in the formula for the third exopod segment of leg 4 which is II, I, 5 compared with I, I, 5 in the latter.

No phoronid has previously been recorded as host to a copepod. *Cerianthus*, with which the *Phoronis* is associated, is host to the copepod *Boholia cerianthiphila* Kossmann in the Philippine Islands (Kossmann, 1877). This lichomolgid has not been recorded since its original description and was regarded as insufficiently described or of uncertain position by Humes & Stock (1973) in their revision of the family. The original description of *B. cerianthiphila* shows that it possesses 2 strong claws at the apex of the second antenna whereas *Phoronicola* has 3 slender articulated setiform claws. The segmentation of the body is also different in these two genera. These differences are sufficient to distinguish between them.

Acknowledgements

We would like to thank Professor Brian Morton (University of Hong Kong) for the opportunity to collect this material during the Second International Workshop on the Flora and Fauna of Hong Kong and Southern China held during April 1986. We are also grateful to Dr P. G. Oliver (National Museum of Wales) who collected the phoronid host.

References

Humes, A. G. & Boxshall, G. A. 1988. Poecilostome copepods associated with bivalve molluscs and a brachiopod at Hong Kong. *Journal of Natural History* **22**: 537–544.

Humes, A. G. & Stock, J. H. 1973. A Revision of the Family Lichomolgidae Kossmann, 1877, Cyclopoid Copepods mainly associated with Marine Invertebrates. *Smithsonian Contributions to Zoology*, **127:** 1–368.

Kossmann, R. 1877. Entomostraca (1. Theil: Lichomolgidae). In: *Zoologische Ergebnisse einer im Auftrage der Koniglichen Academie der Wissenschaften zu Berlin ausgefuhrten Reise in die Kustengebiete des Rothen Meeres*. **IV:** 1–24, pl. 1–6.

Medioni, A. & Soyer, J. 1967. Copépodes Harpacticoides de Banyuls-sur-Mer: Quelques formes récoltées sur des Bryozoaires. *Vie et Milieu*, **18:** 317–343.

Morton, B. S. & Morton, J. E. 1983. *The sea shore ecology of Hong Kong*. Hong Kong University Press: 350pp.

Manuscript accepted for publication 6 May 1988